

What is Claimed is:

1. A powder batch comprising composite electrocatalyst particles, said electrocatalyst particles comprising a support phase and an active species phase dispersed on said support phase, wherein said support phase comprises primary support
5 particles having an average size of from about 10 to about 100 nanometers, wherein the average cluster size of said active species phase is not greater than about 20 nanometers and wherein said electrocatalyst particles have a surface area of at least about 90 m²/g.

2. A powder batch as recited in Claim 1, wherein said active species phase has an average cluster size of from about 0.5 nanometers to about 5 nanometers.

10 3. A powder batch as recited in Claim 1, wherein at least about 50 percent of said active species phase has a cluster size of not greater than about 3 nanometers.

4. A powder batch as recited in Claim 1, wherein said active species phase comprises a metal.

15 5. A powder batch as recited in Claim 1, wherein said active species phase comprises a platinum group metal.

6. A powder batch as recited in Claim 1, wherein said active species phase comprises a metal oxide.

7. A powder batch as recited in Claim 1, wherein said active species phase comprises a transition metal oxide.

20 8. A powder batch as recited in Claim 1, wherein said active species phase comprises manganese oxide.

9. A powder batch as recited in Claim 1, wherein said electrocatalyst particles have a surface area of at least about 200 m²/g.

25 10. A powder batch as recited in Claim 1, wherein said primary support particles comprise carbon.

11. A powder batch as recited in Claim 1, wherein said primary support particles comprise graphitic carbon.

12. A powder batch as recited in Claim 1, wherein said electrocatalyst particles have an average particle size of not greater than about 10 μm.

30 13. A powder batch as recited in Claim 1, wherein said electrocatalyst particles have an average particle size of from about 1 μm to about 10 μm.

14. A powder batch as recited in Claim 1, wherein said electrocatalyst particles are substantially spherical.

15. A powder batch as recited in Claim 1, wherein said electrocatalyst particles comprise from about 20 to about 40 weight percent of said active species phase.

5 16. A powder batch as recited in Claim 1, wherein said electrocatalyst particles have a porosity of at least about 40 percent.

17. A powder batch of metal-carbon composite electrocatalyst particles, said electrocatalyst particles comprising a carbon support phase and a metal active species phase dispersed on said support phase, wherein said support phase comprises primary carbon particles having an average size of from about 20 to about 40 nanometers and
5 wherein the average cluster size of said metallic active species phase is not greater than about 10 nanometers.

18. A powder batch as recited in Claim 17, wherein said metallic active species phase comprises a platinum group metal.

19. A powder batch as recited in Claim 17, wherein said metallic active species
10 phase comprises platinum metal.

20. A powder batch as recited in Claim 17, wherein said active species phase comprises a metal alloy.

21. A powder batch as recited in Claim 17, wherein said electrocatalyst powders have a surface area of at least about 200 m²/g.

22. A powder batch as recited in Claim 17, wherein said electrocatalyst powders
15 have a porosity of at least about 40 percent.

23. A powder batch as recited in Claim 17, wherein at least about 50 weight percent of said active species phase has a cluster size of not greater than about 3 nanometers.

24. A powder batch of composite electrocatalyst particles, said electrocatalyst particles comprising a carbon support phase and a metal oxide active species phase dispersed on said support phase, wherein said support phase comprises primary support particles having an average size of from about 20 to about 40 nanometers and wherein the
5 average cluster size of said metal oxide active species phase is not greater than about 10 nanometers.

25. A powder batch as recited in Claim 24, wherein said metal oxide active species phase comprises a transition metal oxide.

26. A powder batch as recited in Claim 24, wherein said metal oxide active
10 species phase comprises manganese oxide.

27. A powder batch as recited in Claim 24, wherein said electrocatalyst particles have a surface area of at least about 200 m²/g.

28. A powder batch as recited in Claim 24, wherein said electrocatalyst particles have a porosity of at least about 40 percent.

29. A method for the production of composite electrocatalyst particles, comprising the steps of:

a) generating an aerosol of droplets from a precursor liquid wherein said precursor liquid comprises at least a first precursor to a support phase and at least a second precursor to an active species phase;

b) moving said droplets in a carrier gas; and

c) heating said droplets to remove liquid therefrom and react at least one of said first and second precursors to form composite electrocatalyst particles wherein said active species phase is dispersed on said support phase.

30. A method as recited in Claim 29, wherein said carrier gas is air.

31. A method as recited in Claim 29, wherein said carrier gas is nitrogen.

32. A method as recited in Claim 29, wherein said heating step comprises passing said droplets through a heating zone having a reaction temperature of not greater than about 400°C.

33. A method as recited in Claim 29, wherein said heating step comprises passing said droplets through a heating zone having a reaction temperature of not greater than about 300°C.

34. A method as recited in Claim 29, wherein said active species phase is a metal and wherein said precursor liquid further comprises a reducing agent.

35. A method as recited in Claim 29, wherein said active species phase is a metal oxide and wherein said precursor liquid further comprises an oxidizing agent.

36. A method as recited in Claim 29, wherein said first precursor comprises particulate carbon.

37. A method as recited in Claim 29, wherein said first precursor comprises particulate carbon having a surface area of at least about 200 m²/g.

38. A method as recited in Claim 29, wherein said first precursor comprises particulate carbon having an average size of from about 20 to about 40 nanometers.

39. A method as recited in Claim 29, wherein said step of generating an aerosol comprises ultrasonically atomizing said liquid.

40. A method as recited in Claim 29, wherein said step of generating an aerosol comprises passing said precursor liquid through a two-fluid nozzle.

41. A method for the production of composite electrocatalyst particles, comprising the steps of:

- a) forming a liquid precursor comprising a particulate carbon precursor and at least a first precursor to an active species phase;
- b) generating an aerosol of droplets from said liquid precursor; and
- c) heating said aerosol of droplets in a spray dryer at a conversion temperature of not greater than about 400°C to form electrocatalyst particles wherein said first precursor is converted to an active species phase dispersed on said support phase.

42. A method as recited in Claim 41, wherein said liquid precursor comprises a reducing agent.

43. A method as recited in Claim 41, wherein said liquid precursor comprises an oxidizing agent.

44. A method as recited in Claim 41, wherein said conversion temperature is not greater than about 300°C.

45. A method as recited in Claim 41, wherein said particulate carbon precursor has a surface area of at least about 600 m²/g.

46. A method as recited in Claim 41, wherein said step of generating an aerosol comprises passing said liquid precursor through a two-fluid nozzle.